N87-22343

DoD (USAF) TURBULENCE ACCIDENTS AND INCIDENTS

Douglas Miller
USAF Inspection and Safety Center
Norton AFB, California

This presentation is a summary of Air Force turbulence-related mishaps for the last ten years of Air Force mishaps from a perspective of where we have been, where we are now, and where we are going. In addition to accounts of major mishaps, a summary of what actions were taken to preclude future similar mishaps will be presented. Also, a discussion of some of the things being done now and being planned for the future to prevent turbulence-related mishaps will be presented.

Before presenting this summary, a short explanation of how mishaps are classified is in order. The mishaps to be discussed in detail fall into a Class A category. Class A mishaps are defined as a mishap resulting in:

1. Total cost of $500,000 or more for injury, occupational illness, and property damage, or

2. A fatality, or permanent total disability, or

3. Destruction of, or damage beyond economical repair to, an Air Force aircraft.

The DoD as a whole uses pretty much this same system.

The definition of our Class B mishap category is a mishap resulting in:

1. Total cost of $100,000 or more, but less than $500,000, for injury, occupational illness, and property damage, or

2. A permanent partial disability, or

3. Hospitalization of five or more personnel.

Do not pay much attention to the Class B parameters since none of the Air Force turbulence-related mishaps fell into this category.

The definition of our Class C mishap category is a mishap resulting in:

1. Total damage which costs $10,000 or more, but less than $100,000

2. Any injury or occupational illness which results in a lost workday case involving days away from work (i.e., 8 hours or greater), or

3. A mishap which does not meet the criteria above, but which Chapters 5 through 9 require reporting.

Until January 1, 1986, the dollar limits for Class C damage ranged from $1000 to $100,000 (the Air Force just recently raised the lower limit to $10,000).

To give a perspective on the size of flight operations during this study, in 1985 the Air Force has possessed 9,927 active aircraft and flew 3,488,000 flight hours since 1976.

Table 1 shows the total numbers of Classes A, B, and C mishaps we have experienced in the last ten years as well as the number of turbulence-related mishaps which we have experienced by mishap category. From a statistical point of view, a very small percentage of our mishaps are turbulence related. However, as shown in Table 2, there is a problem that the Air Force has taken seriously from actions taken in our Air Force turbulence-related Class A mishaps.

TABLE 1. Total Air Force Class A, B, and C Mishaps and Turbulence-Related Mishaps from 1976 to 1985.

CLASS A	CLASS B	CLASS C
782	931	36,729
TURBULENCE RELATED:		
CLASS A	CLASS B	CLASS C
5	0	17

The first turbulence-related Class A mishap in my study occurred when one of our transport aircraft flew into or near a thunderstorm. The aircraft had departed home base with weather radar problems. The radar set was repaired prior to departure but failed again during the flight. Arriving near their destination, they found that there was significant weather between their position and their destination base. Civil air traffic control (ATC) advised them of a temporary radar failure, and that there was pretty solid cover between them and their destination. Ironically, military radar was tracking them and the Air Force possesses radar pictures of the weather conditions and aircraft for this flight. The controller stated, "There's no way I can get you around it." The aircrew indicated that they were in visual meteorological conditions (VMC) and would visually circumnavigate the thunderstorms. Two minutes later, the aircraft failed to respond to a transponder change. The aircraft broke apart in flight, went out of control, and crashed. Crew members and passengers perished in the crash. The aircraft had flown close to thunderstorm cells and, as a result, encountered extreme turbulence which failed the #4 pylon and right wing.

A lot of action was generated by this mishap. For example, the weather radar which had been experiencing a lot of reliability and maintainability problems was replaced with a much better and more reliable system. The Air Force came out with much more specific guidance on thunderstorm avoidance in our basic flight rules. Finally, there was a call for increased research in the area of severe weather avoidance.

A Multiagency Conference on Severe Convective Storms and Their Hazards to Aviation was held on February 16 and 17, 1977. A number of agencies were represented at this conference: National Weather Service, Environmental Research Labs, National Severe Storms Lab, National Severe Storms Forecast Center, FAA, NTSB, NASA, Lockheed, University of Chicago, and Air Force Inspection and Safety Center.

Some of the recommendations that came out of the conference are given in Table 3. With regards to the first recommendation, a number of studies have been conducted on thunderstorms by the National Severe Storms Lab and other agencies. For the second, the Air Force has acquired films on thunderstorm avoidance and other training aids. The third recommendation was covered in our corrective action. The fourth, a test program was established to see if full-time weather expertise would be useful at Kansas City Air Route Traffic Control Center. Flight simulation techniques have been developed for low-level wind shear and are used in Air Force cargo aircraft flight simulator programs. The last recommendation was covered in our corrective action.

The second major mishap occurred when a trainer aircraft penetrated a thunderstorm at high altitude. The mishap pilot accepted a routing from air traffic control which had more severe weather than what had been forecast for this flight planned route. When the pilot entered significant weather, he reported it to ATC. The controller offered the pilot a 180° turn as there were cells in all quadrants. The pilot received clearance to climb (even though the aircraft was already out of its engine operating envelope). At flight level 464, still in the cell, both engines flamed out. The aircraft traveled 5.4 nautical miles from its last radar painted position to its point of impact in 2 minutes 9 seconds. It was hypothesized that severe turbulence within the storm contributed to spatial disorientation and a delayed decision to eject. The aircraft did not have an on-board weather radar. The mishap pilot had significant flight experience, including being a graduate of Air Force Test Pilot School, but let his good judgment get side-tracked by intense motivation to get to his destination. There were no weather-related corrective actions taken as a result of this mishap.

Our third Class A mishap occurred in 1985 when a forward air controller (FAC) aircraft, encountered turbulence and downdrafts associated with a mountain wave phenomena. Mountain wave had not been forecast prior to the mishap flight. A pilot report of severe turbulence was issued by a helicopter after the mishap aircraft was airborne, but the information was not relayed to the mishap pilot. It was determined that the mishap aircraft got into an area of downdrafts which exceeded the aircraft's capability to climb to avoid terrain. Search for the crash site was hampered by severe turbulence in the area.

As a result of this mishap, a warning was put in the aircraft flight manual that in even moderate turbulence vertical gust velocities could exceed the aircraft's climb capabilities.

Less than two months later, another FAC aircraft was lost when it penetrated severe weather as it attempted to return to base during a weather recall. The mishap pilot whose visual routes of escape had been closed off by weather moving in from all directions decided to climb to 5,000 feet in instrument meteorological conditions (IMC) so that he could be radar vectored around the severe weather. During his IMC climb, he encountered a severe updraft which he interpreted as an attitude indicator failure. He then made a right descending turn to get back into visual (VMC) conditions. The mishap pilot then failed to reduce his high-power setting and the aircraft entered a nose-low, high-speed descent. The left wing failed at approximately 2,500 feet AGL due to high speed and turbulence. The aircraft entered a left uncontrollable roll and was completely destroyed on impact, fatally injuring the pilot.

Actions and suggestions coming from this mishap were similar to those of the other FAC aircraft mishaps. A warning regarding the dangers of flying low to medium performance aircraft in the vicinity of severe updrafts or downdrafts were recommended for Air Force Manual 51-12, "Weather for Aircrew," as well as a similar warning for the aircraft flight manual.

Finally, in our last turbulence-related mishap a transport aircraft was performing a medical evacuation mission into a remote site. Crosswinds on this approach were high requiring occasional full use of cross controls. A turbulent downdraft destabilized the aircraft a quarter mile from the runway. As this was a one-way site, one that requires that you fly your approach in one direction and your departure in the opposite direction--due to rising terrain in three quadrants--and they were already past the commit point (the point past which go-around is improbable), the pilot was committed to land. The aircraft touched down in a left drift and continued to drift left until it departed the runway. The aircraft sustained significant damage. There were no weather-related corrective actions taken as a result of this mishap. This concludes the look at our Class A turbulence-related mishaps.

Table 4 summarizes the last ten years of Class C turbulence-related mishaps. A Class C mishap is any damage that is between $1000 and $100,000. I will not go into detail on these mishaps unless someone has a particular question. Copies of our Class C investigations are not retained except for a brief narrative summary which is put into our computer. If the summary mentioned that turbulence was forecast, this was noted as a yes or no; if it was not mentioned, unknown (UNK) was noted. Also, if the airspeeds and altitudes at which the turbulence was encountered were contained in the summary, this is noted on the charts.

In reviewing the Class C mishaps, two major trends were noticed. First, that most of these mishaps occurred in large aircraft and second that most turbulence-related injuries were sustained by unrestrained occupants. In talking with fighter aircraft action officers (by the way, I am the C-130 action officer), their comment was that high-performance aircraft are not usually adversely affected by turbulence. Fighter aircraft are built for high "G" loading, and when they do hit turbulence, crew members are always well restrained.

I believe the reason we have a very good record in the area of turbulence-related mishaps is that our aircrews maintain a high level of awareness of severe weather. It is a frequent topic in our safety magazines, it is covered in pilot training, annual instrument refresher training, and aircrew briefings from our Air Weather Service people. Another factor is that good weather forecasting keeps us away from severe weather and turbulence.

Some areas where I see improvement for the future in turbulence avoidance includes better aircraft and ground-based weather radar. NEXRAD, which should come on line in the early 1990's, will have a turbulence algorithm. For improved forecasting, the Air Weather Service has recently completed a geophysical requirement for future turbulence research (defining Air Force and Army future forecasting needs). It is presently under review at Air Force Geophysics Labs. Dr. Dale Meyer from Air Weather Service, who was at this conference, is involved in this effort and has told me that he would be glad to give any of you who are interested in this geophysical requirement an overview of the project.

QUESTION: Dave O'Keefe (Lockheed). I noticed in your Class C you had an F105 where the vertical stabilizer broke apart or suffered damage due to turbulence. Was there any indication that there was a fatigue problem or there were corrosion problems? Were there any investigations as to why that stabilizer broke apart?

ANSWER: No, we do not retain copies of our Class C investigations. All I had to go on was a computer short summary. There were no indications at all of structural fatigue. The F105 is an old airplane, but it seems that if there had been indications, they would have been mentioned in our findings and they weren't.

QUESTION: Capt. Ed Harrison (The Pentagon). As the C130 action officer you should be well equipped to answer this one. I noticed the Air Force uses C130's for hurricane and typhoon reconnaissance. I was just curious as to their weather-related safety record. They are flying directly into the jaws of danger. Do they have a significant experience with turbulence-related incidents?

ANSWER: That is a good question. I know of one C130 mishap of a weather C130 flying into a typhoon in the Pacific in 1974. They never found the airplane so they were never able to determine what exactly caused the failure of the aircraft.

QUESTION: Mike Tomlinson (Air Weather Service). In your listing of the factors that you think are involved in a relatively good safety record, a factor that I didn't see that I think should be there is the need for pretty tight operational rules that specify when certain levels of turbulence are forecast. Do you think that is a significant factor, and because you're not out there when the forecast calls for severe turbulence, are you less likely to be exposed to those conditions and have resulting accidents?

ANSWER: Yes, you are. I guess I did fail to mention that as a result of that 1976 C141 accident, they did come up with very specific guidance on thunderstorm avoidance. And that has, unfortunately, been relaxed since that time. For a while the Air Force as a whole had a regulation telling you how far you had to stay away from thunderstorms. You had to be 20 miles downwind or 10 miles upwind, I don't remember the exact parameters. After that, the fighter community wanted different limitations. That parameter still exists in military airlift command supplement to 60-16, the general flight rules, but it is not in the Air Force regulation itself. But you're right. It is very true that we do have a lot of operating restrictions that keep us out of severe weather.

COMMENT: Dale Meyer (HQ Air Weather Service). As was pointed out, I will be glad to discuss our perspective of Air Force and Army requirements.

QUESTION: George Treviño (Michigan Tech). Will photocopies of all these slides and presentations be made available to the participants?

ANSWER: To answer your question on my briefing in particular, there are parts of it in which I went into specifics, such as places and types of aircraft, and they are "For Official Use Only." What I'm going to do is give to the workshop organization all of my briefing which is not restricted and present a summary that won't name the specific aircraft.

QUESTION: Al Bedard (NOAA). You have a criteria for classifying the strength of turbulence which I believe dealt with the G forces, if I read that slide correctly. Is that widely accepted by the defense community or is that your own internal classification?

ANSWER: That is something I think AWS would be better at answering. I think Dr. Meyer can probably answer that better than I can.

ANSWER: Dale Meyer (HQ Air Weather Service). We do have a procedure that was developed by the Air Force Wright Aeronautical Laboratories in 1981 that uses gust loading to classify all Air Force aircraft into four categories. We use that information operationally in tailoring our forecasts and interpreting PIREPS. I don't have the details with me but I have access to them.

TABLE 2. Air Force Turbulence-Related Class A Mishaps.

TRANSPORT AIRCRAFT IN-FLIGHT BREAKUP; NEAR THUNDERSTORM
TRAINER AIRCRAFT CONTROL LOSS; IN THUNDERSTORM
FORWARD AIR CONTROLLER (FAC) COLLISION WITH THE GROUND DURING MOUNTAIN WAVE ENCOUNTER
FAC AIRCRAFT IN-FLIGHT BREAKUP IN THUNDERSTORM UPDRAFTS AND TURBULENCE
TRANSPORT AIRCRAFT RUNWAY DEPARTURE AFTER APPROACH DESTABILIZED BY TURBULENT DOWNDRAFT

TABLE 3. Multiagency Conference on Severe Convective Storms and Their Hazards to Aviation.

RECOMMENDATIONS

- THE NEED FOR BASIC RESEARCH INTO THE LOCATION, DURATION, AND INTENSITY OF TURBULENCE IN THE VICINITY OF THUNDERSTORMS
- NEW AIRCREW TRAINING AIDS
- BETTER GROUND-BASED AND AIRBORNE-WEATHER RADAR
- ASSIGNING FULL-TIME WEATHER EXPERTISE IN THE AIR TRAFFIC CONTROL SYSTEM
- DEVELOP FLIGHT SIMULATION TECHNIQUES WITH REGARD TO LOW-LEVEL WIND SHEAR
- REVIEW AND STRENGTHEN REGULATIONS AND CRITERIA WITH REGARD TO PENETRATING HAZARDOUS WEATHER

TABLE 4. Class C Turbulence-Related Mishaps.

	WAS TURBULENCE FORECAST	ALTITUDE/AIRSPEED	DAMAGE
1976			
T-39A	NO	FL410/220 KIAS	ENGINE FLAMEOUT
EC-135J	UNK	FL310	CAT CAUSES OSCILLATIONS/FAILURE OF TRAILING WIRE ANTENNA
1977			
C-130B	UNK	FL110	CHAIN BOX LATCHES FAIL WHEN A/C ENCOUNTERS SEVERE TURBULENCE IN CLOUD
B-52G	YES/MOD	HIGH ALT/300 KIAS	SEVERE TURB THROWS CREW VIOLENTLY ABOUT
T-38A	UNK	FL210/300 KIAS	DAMAGE TO LEADING EDGES OF BOTH WINGS AND VERT STABILIZER WHEN AIRCRAFT ENTERED AREA OF HEAVY RAIN AND MODERATE TO SEVERE TURBULENCE
1978			
B-52G	YES	TRAFFIC PATTERN/	DAMAGE TO FLAPS WHEN A/C ENCOUNTERED MODERATE TURBULENCE IN RAINSHOWERS
1979			
C-130H	NO	LOW ALT	LOADMASTER BREAKS LEG WHEN A/C ENCOUNTERS SEVERE CAT
B-52H	YES	UNK	MODERATE TURBULENCE CAUSED DAMAGE TO BOMB DOORS, WHILE OPEN
EC-135H	UNK	FL330	TRAILING WIRE ANTENNA SEPARATES DUE TO CAT
1980			
C-130A	UNK	1000 AGL/125 KIAS	LOADMASTER BREAKS WRIST WHEN A/C ENCOUNTERS CAT
C-130B	NO	UNKNOWN	CREW CHIEF INJURES BACK WHEN A/C ENCOUNTERS MODERATE CAT
1981			
C-130A	UNK	FL180/240 KIAS	TWO CREWMEMBERS INJURED WHEN A/C ENCOUNTERS A SEVERE DOWNDRAFT

TABLE 4. (concluded).

	WAS TURBULENCE FORECAST	ALTITUDE/AIRSPEED	DAMAGE
1981			
F-105D	UNK	1000 FT AGL/ 500 KIAS	PART OF VERTICAL STABILIZER LOST WHEN A/C ENCOUNTERED SEVERE TURBULENCE EN ROUTE TO RANGE
C-130H	NO	FL160	TWO CREWMEMBERS INJURED WHEN A/C ENCOUNTERS ABRUPT SEVERE CAT
1982			
KC-135	YES	3000 MSL	PASSENGER INJURED WHEN A/C ENTERS AREA OF HEAVY WEATHER AND SEVERE TURBULENCE
1985			
KC-135A	UNK	FL220	A/C SUSTAINS CRACKS IN ALL FORWARD ENGINE MOUNTS WHEN A/C ENCOUNTERS SEVERE TURBULENCE
C-130B	YES	LOW LEVEL	FIVE AIRCREW SUSTAIN INJURIES WHEN A/C ENCOUNTERS MOUNTAIN WAVE